

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. (Currently Amended) A bone fixation apparatus comprising:

a bone fixation plate having a fixation hole, the fixation hole substantially completely bounded by an inner spherical surface; and

a modular bone fixation fastener received in the fixation hole, the bone fixation fastener including a shaft member defining a longitudinal axis and an expandable annular head member defining an internal surface, the shaft member defining a circumferential outer cam at a first end, the outer cam in the form of a continuous curve of continuous slope and circumferentially variable radius in a plane perpendicular to the longitudinal axis, the internal surface of the head member defining a circumferential inner cam in the form of a continuous curve of continuous slope and circumferentially variable radius and devoid of kinks, the outer cam circumferentially mating with the inner cam of the head member in a position of cam alignment, such that upon rotation of the head member relative to the shaft member to a first position of cam misalignment, the head member radially expands to prevent back out of the shaft member relative to the bone fixation plate, the modular fixation fastener positionable at a plurality of angles relative to the fixation plate in the first position of cam misalignment through articulation of the expandable head member relative to the fixation hole.

2. (Previously Presented) The bone fixation apparatus of Claim 1, wherein the outer cam and the inner cam each have at least one lobe, the lobe defined as a segment radially offset from the internal surface of the head member.

3. (Previously Presented) The bone fixation apparatus of Claim 1, wherein the outer cam and the inner cam each have a plurality of lobes, the lobes interconnected by variable radius curves.

4. (Original) The bone fixation apparatus of Claim 1, wherein the fixation hole includes a countersunk portion receiving at least a portion of the expandable head member of the bone fixation fastener.

5. (Previously Presented) The bone fixation apparatus of Claim 1, wherein each of the outer and inner cams includes three equidistant lobes, the lobes interconnected by variable radius curves.

6. (Currently Amended) The bone fixation apparatus of Claim 1, wherein an ~~the~~ inner surface of the fixation hole ~~is spherical and~~ engages a spherical outer surface of the head member.

7. (Original) The bone fixation apparatus of Claim 1, wherein the bone fixation plate includes a viewing window.

8. (Original) The bone fixation apparatus of Claim 1, wherein the bone fixation plate is a spinal fixation plate for securing first and second vertebral bodies relative to one another.

9. (Original) The bone fixation apparatus of Claim 1, wherein the bone fixation plate is a spinal fixation plate for securing at least three vertebral bodies relative to one another.

10. (Previously Presented) The bone fixation apparatus of Claim 8, further comprising at least one viewing window.

11. (Original) The bone fixation apparatus of Claim 1, further comprising at least one aperture receiving an anchoring fastener.

12. (Original) The bone fixation apparatus of Claim 1, further comprising at least another fixation hole receiving another modular fixation fastener.

13. (Original) The bone fixation apparatus of Claim 1, in combination with an insertion and removal tool, the tool comprising a first driver attached to a handle, the driver adapted to engage the head member for rotation of the head member relative to the shaft member.

14. (Original) The bone fixation apparatus of Claim 13, wherein the tool comprises a second driver adapted to engage the shaft member for inserting and removing the shaft member to and from a bone portion when the fixation member is not locked.

15. (Previously Presented) The bone fixation apparatus of Claim 1, wherein upon rotation of the head member relative to the shaft member to a second position of cam misalignment, the head member radially expands against an inner surface of the fixation hole to pressure-lock the fixation fastener and thereby prevent relative movement between the fixation fastener and the plate locking the fixation fastener at a fixed orientation relative to the plate.

16. (Previously Presented) The bone fixation apparatus of Claim 1, wherein the head member and the shaft member are cooperatively configured to provide a first mode of operation in which the head member is prevented from backing out relative to the plate and the fixation fastener is adjustable relative to the plate and a second mode of operation in which the head member is prevented from backing out relative to the plate and the fixation fastener is arrested relative to the plate.

17. (Currently Amended) A bone fixation apparatus comprising:

a bone fixation plate having a fixation hole, the fixation hole substantially completely bounded by an inner spherical surface; and

a modular bone fixation fastener received in the fixation hole, the bone fixation fastener comprising:

a shaft member having a first end, the first end defining a circumferential multi-radius continuously curved outer surface, the outer surface having continuous slope and defining a circumferential shaft cam lobe; and

an expandable head member having an inner opening defining an internal circumferential surface in the form of a circumferentially multi-radius continuously curved inner surface, the inner surface having continuous slope and being devoid of kinks and defining a head cam lobe circumferentially mating with the shaft cam lobe in a position of cam alignment, such that upon rotation of the head member relative to the shaft member, the shaft cam lobe rotates out of alignment relative to the head cam lobe forcing the head member to expand radially to prevent back out of the shaft member relative to the bone fixation plate, the modular fixation fastener positionable at a plurality of angles relative to the fixation plate through articulation of the expandable head member relative to the fixation hole when the head member is unexpanded.

18. (Previously Presented) The bone fixation apparatus of claim 17, wherein the head member radially expands against an inner surface of the fixation hole to pressure-lock the fixation fastener and thereby prevent relative movement between the fixation fastener and the plate.

19. (Previously Presented) The bone fixation apparatus of claim 17, wherein the inner head surface and the outer shaft surface each define a plurality of mating cam lobes, the lobes interconnected by variable radius curves.

20. (Currently Amended) The bone fixation apparatus of claim 19, wherein the inner surface of the fixation hole ~~is spherical and~~ engages a spherical outer surface of the head member.

21-36. (Canceled)

37. (Currently Amended) A bone fixation apparatus comprising:

a bone fixation plate having a fixation hole, the fixation hole having a first diameter in a plane generally parallel to an upper surface of the bone fixation plate, the fixation hole substantially completely bounded by an inner spherical surface; and

a modular bone fixation fastener received in the fixation hole, the bone fixation fastener including a shaft member defining a shaft axis and an expandable annular head member carried by the shaft member, the expandable head member being expandable by rotation about the shaft axis relative to the shaft member from a first circumferential position in which the head member is not expanded to a second circumferential position in which the head member is expanded, such that in the first position the expandable head member has a maximum diameter that is smaller than the first diameter of the fixation hole, and in the second position the expandable head member has a maximum diameter that is greater than the first diameter,

wherein the head member and the shaft member are cooperatively configured to provide a first mode of operation in which the head member is prevented from backing out relative to the plate and the fixation fastener is adjustably angled relative to the plate through articulation of the expandable head member relative to the fixation hole, and a second mode of operation in which the head member is prevented from backing out relative to the plate and the fixation fastener is locked at a fixed angle relative to the plate.

38. (Original) The bone fixation apparatus of claim 37, wherein the expandable head member has a generally spherical outer surface.

39. (Canceled)

40. (Previously Presented) The bone fixation apparatus of claim 37, wherein the shaft member has a circumferential outer shaft cam mating with a corresponding circumferential internal head cam of the head member, such that in the first circumferential position the head and shaft cams are aligned and in the second circumferential position the head and shaft cams are misaligned, and wherein the each of the head and shaft cams is defined by a continuous curve of circumferentially variable radius and continuous slope.

41. (Previously Presented) The bone fixation apparatus of claim 40, wherein each cam includes a plurality of lobes interconnected with variable-radius curves, and wherein in the second position the fastener is pressure locked against the fixation hole and thereby prevents relative movement between the fixation fastener and the plate.

42-44. (Canceled)

45. (Currently Amended) A bone fixation apparatus comprising:

a bone fixation plate having a fixation hole, the fixation hole substantially completely bounded by an inner spherical surface; and

a modular bone fixation fastener received in the fixation hole, the bone fixation fastener comprising:

a shaft member having a longitudinal axis and a first end, the first end defining a continuous outer shaft cam curve on a plane perpendicular to the longitudinal axis, the outer shaft cam curve defining a plurality of cam lobes interconnected with curves of variable radius; and

an expandable head member having an inner opening defining a continuous inner head cam curve, the inner head cam curve circumferentially mating and aligned with the outer shaft cam curve in an unexpanded configuration, the inner head cam curve circumferentially misaligned relative to the outer shaft cam curve in an expanded configuration, wherein the modular fixation fastener is adjustably angled relative to the plate through articulation of the expandable head member relative to the fixation hole in the unexpanded configuration.

46. (Currently Amended) The bone fixation apparatus of claim 45, wherein the head member has an outer spherical surface engageable with the inner spherical surface of the fixation hole and includes driver engagement formations for rotating the head member relative to the shaft member for moving the head member between the unexpanded and expanded configurations.